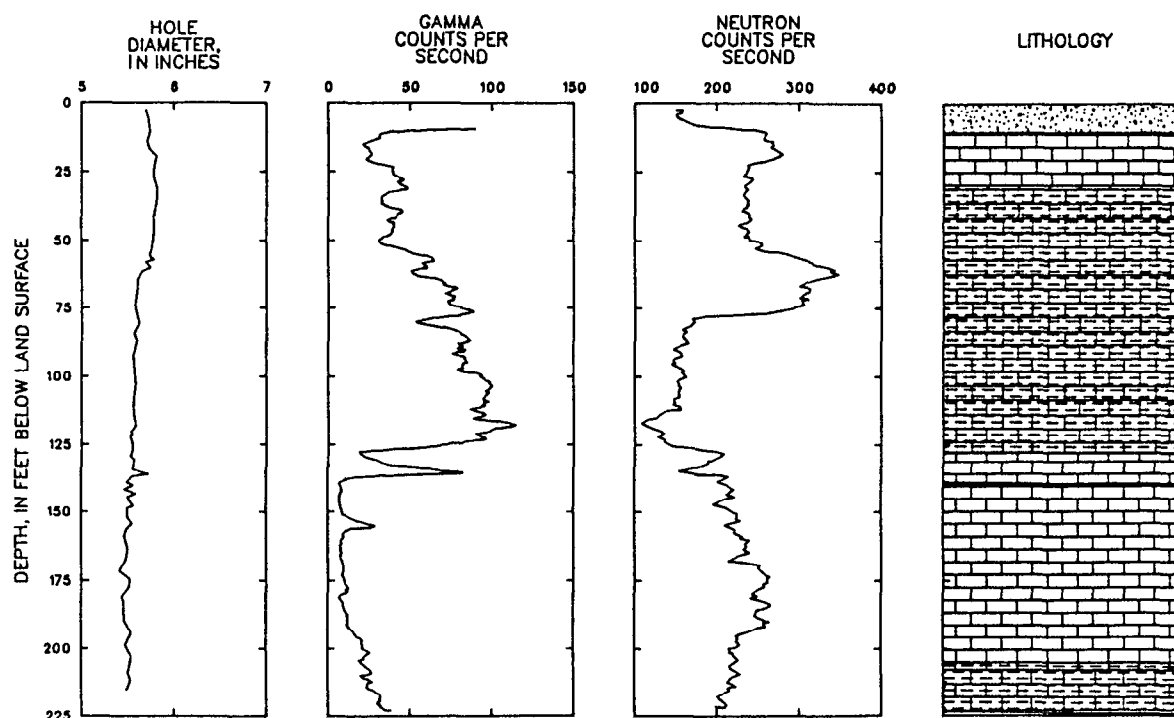


CONSTRUCTION, GEOLOGIC, AND WATER-LEVEL DATA FOR OBSERVATION WELLS NEAR BRENTWOOD, WILLIAMSON COUNTY, TENNESSEE



Prepared by the
U.S. GEOLOGICAL SURVEY



in cooperation with the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF SUPERFUND



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**CONSTRUCTION, GEOLOGIC, AND WATER-LEVEL DATA
FOR OBSERVATION WELLS NEAR BRENTWOOD,
WILLIAMSON COUNTY, TENNESSEE**

by Dorothea Withington Hanchar

U.S. GEOLOGICAL SURVEY

Open-File Report 87-248

**Prepared in cooperation with the
TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF SUPERFUND**



Nashville, Tennessee

1989

DEPARTMENT OF THE INTERIOR

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CONSTRUCTION, GEOLOGIC, AND WATER-LEVEL DATA FOR OBSERVATION WELLS NEAR BRENTWOOD, WILLIAMSON COUNTY, TENNESSEE

By Dorothea Withington Hanchar

ABSTRACT

Thirty-four observation wells were installed at 17 sites in the area of a hazardous-waste disposal site near Brentwood, in Williamson County, Tennessee. These wells were installed to supplement data collected from domestic wells in the area, to help define the geology of the study area, and to determine water levels. Both lithologic and geophysical logs were obtained for each well drilled to help define the formations encountered. Four limestone units, corresponding to the Bigby-Cannon Limestone, the Hermitage Formation, the Carters Limestone (including the T-3 bentonite), and the Lebanon Limestone, were described from well cuttings and borehole geophysical logs. Water levels have been collected at both the shallow and deep wells at each site.

feet thick on top of limestone bedrock. The limestone formations encountered in this area, in descending order, are the Bigby-Cannon Limestone, Hermitage Formation, Carters Limestone and Lebanon Limestone, all of Ordovician age (Wilson and Miller, 1963). Water-bearing zones occur in the Bigby-Cannon and Carters Limestones, whereas the Hermitage Formation and the Lebanon Limestone are potential confining units. Two wells were drilled at each site in order to determine water levels in each of the potential aquifers. The work was performed in cooperation with the Superfund Division of the Tennessee Department of Health and Environment as part of a more comprehensive study of the hydrogeology of the disposal site and surrounding area.

INTRODUCTION

This report summarizes geologic and water-level data obtained from well installations in the vicinity of a hazardous-waste disposal site near Brentwood, Williamson County, Tennessee (fig. 1). A network of 34 wells was installed from June 1986 to January 1987 at 17 locations in the area surrounding the disposal site (fig. 1). The disposal site and the surrounding area are underlain by a layer of regolith ranging from 0 to 10

DATA COLLECTION

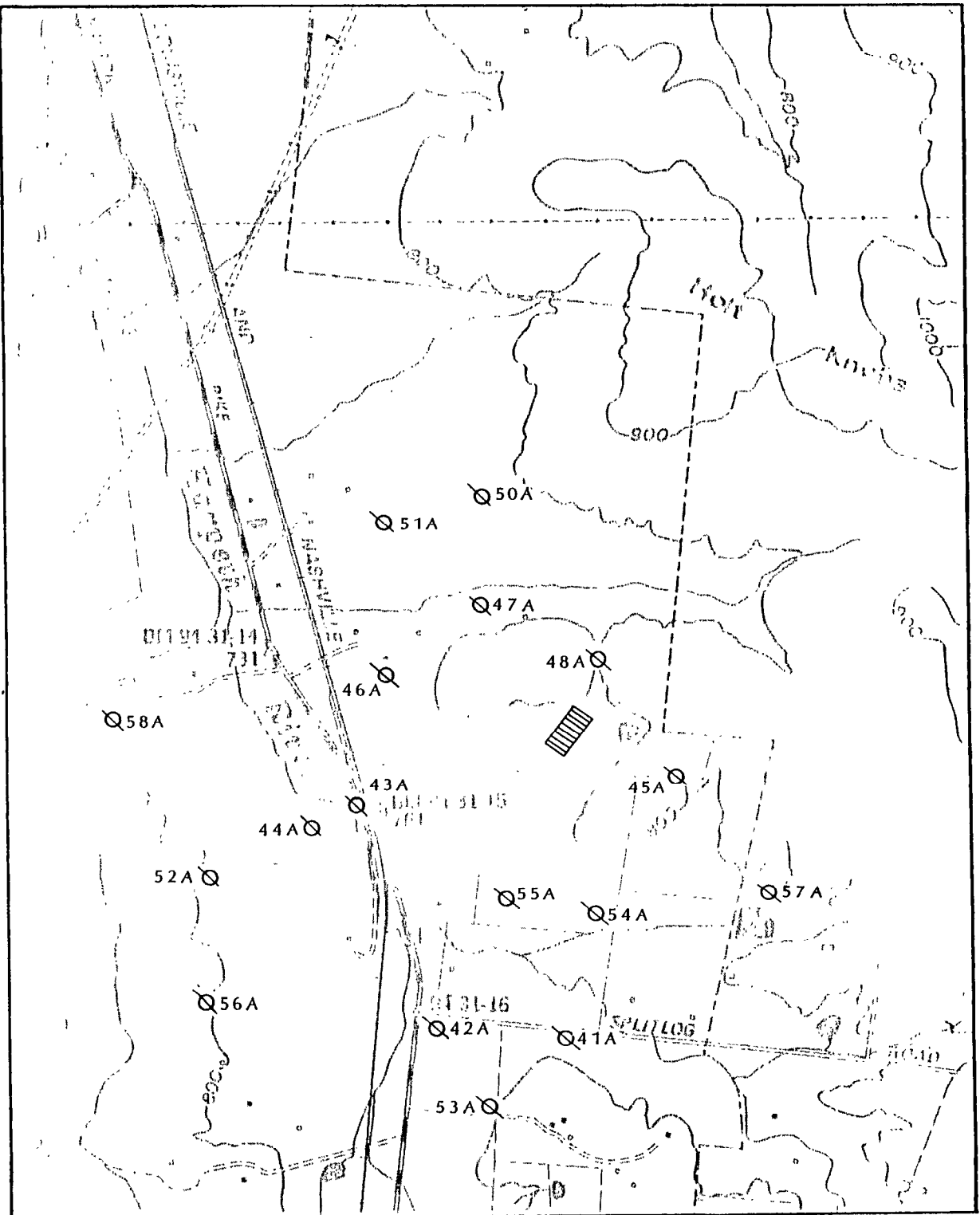
Well Construction

Among the 34 wells drilled, 17 were shallow wells ranging in depth from 20 to 57 feet; 17 were deep wells ranging in depth from 102 to 225 feet. Location coordinates and construction information for each well are summarized in table 1. For all the wells, drilling was accomplished with little or no rock oil in an attempt to limit the amount of hydrocarbons introduced into the wells.

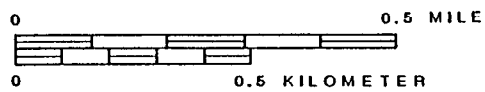
86°47'22"
35°58'

86°45'

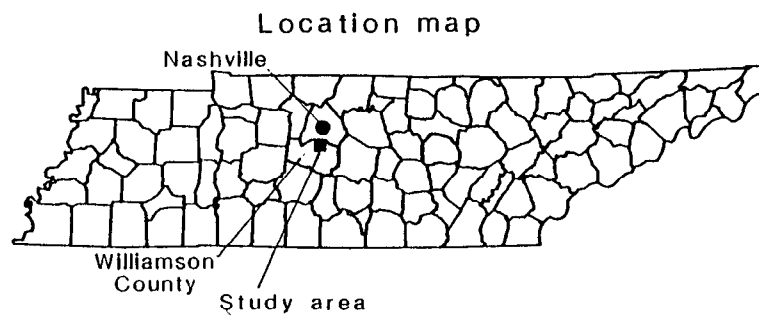
35°57'30"



Base from U.S. Geological Survey
1:24,000, Franklin, 1981



CONTOUR INTERVAL 100 FEET
DATUM IS SEA LEVEL



EXPLANATION



-  DISPOSAL SITE
 53A  OBSERVATION WELL AND NUMBER--Full well
 Identification includes the prefix Wm:N-# #.

Figure 1.—Location of study area and observation wells.

Table 1.--Summary of observation well construction near disposal site

[S = steel casing; p = PVC casing; G = geologists log; J = gamma log;
C = caliper log; N = neutron log; U = bulk density log]

Local well No.	Latitude ° ' "	Longitude ° ' "	Altitude of land surface above NGVD of 1929, in feet	Date of construction	Depth of well below land surface, in feet	Bottom of casing below land surface, in feet	Diameter of casing interval, inches	Casing material available	Type of log available	Height of measuring point above land surface, in feet
WM:N-041	35 57 00	86 45 44	780.1	6/23/86	45	10.0	4.00	S	G	2.20
WM:N-041A	35 57 00	86 45 44	780.9	9/23/86	225	62.0	6.00	S	G	2.50
				--	--	--	--	--	J	
				--	--	--	--	--	C	
				--	--	--	--	--	N	
WM:N-042	35 57 01	86 45 57	754.0	6/23/86	35	10.7	4.00	P	G	2.25
WM:N-042A	35 57 01	86 45 57	753.8	9/22/86	193	34.0	6.00	S	G	2.29
				--	--	--	--	--	J	
				--	--	--	--	--	C	
				--	--	--	--	--	N	
WM:N-043	35 57 20	86 46 06	737.6	6/24/86	28	5.00	4.00	P	G	2.25
WM:N-043A	35 57 20	86 46 06	738.4	10/ 7/86	102	15.0	6.00	S	G	1.70
				--	--	--	--	--	J	
				--	--	--	--	--	C	
				--	--	--	--	--	N	
WM:N-044	35 57 57	86 46 10	744.1	6/25/86	34	5.00	4.00	P	G	2.42
WM:N-044A	35 57 57	86 46 10	738.8	10/ 7/86	102	20.0	6.00	S	G	1.75
				--	--	--	--	--	J	
				--	--	--	--	--	C	
WM:N-045	35 57 23	86 45 33	812.6	6/27/86	49	10.0	4.00	P	G	2.45
WM:N-045A	35 57 23	86 45 32	812.6	10/10/86	167	59.0	6.00	S	G	0.82
				--	--	--	--	--	J	
				--	--	--	--	--	C	
				--	--	--	--	--	N	
WM:N-046	35 57 32	86 46 02	758.0	6/30/86	30	4.50	4.00	P	G	2.48
WM:N-046A	35 57 32	86 46 02	758.7	10/ 9/86	135	15.0	6.00	S	G	1.05
				--	--	--	--	--	J	
				--	--	--	--	--	C	
				--	--	--	--	--	N	
				--	--	--	--	--	U	

Table 1.--Summary of observation well construction near disposal site--Continued

Local well No.	Latitude ° ' "	Longitude ° ' "	Altitude of land surface above NGVD of 1929, in feet	Date of construction	Depth of well below land surface, in feet	Bottom of casing below land surface, in feet	Diameter of casing interval, in inches	Casing material available	Type of log available	Height of measuring point above land surface, in feet
WM:N-047	35 57 38	86 45 51	762.4	7/ 1/86	20	3.10	4.00	S	G	2.14
WM:N-047A	35 57 38	86 45 51	759.9	10/ 9/86	162	17.0	6.00	S	G	1.90
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	N	--
WM:N-048	35 57 33	86 45 40	806.4	7/ 1/86	45	6.00	4.00	P	G	2.23
WM:N-048A	35 57 33	86 45 40	808.8	10/10/86	152	41.0	6.00	S	G	1.34
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	N	--
				--	--	--	--	--	U	--
				--	--	--	--	--	-	--
WM:N-050	35 57 48	86 45 51	785.9	7/ 4/86	45	10.0	4.00	P	G	2.32
WM:N-050A	35 57 48	86 45 51	786.8	10/ 8/86	162	55.0	6.00	S	G	1.10
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	N	--
				--	--	--	--	--	U	--
WM:N-051	35 57 45	86 46 01	754.1	7/ 8/86	25	8.70	4.00	P	G	2.30
WM:N-051A	35 57 45	86 46 01	754.8	10/ 8/86	137	34.0	6.00	S	G	1.15
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	N	--
				--	--	--	--	--	U	--
WM:N-052	35 57 15	86 46 21	791.8	7/ 7/86	35	19.5	4.00	P	G	2.33
WM:N-052A	35 57 15	86 46 21	792.9	10/ 6/86	132	33.0	6.00	S	G	1.73
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	-	--
WM:N-053	35 56 54	86 45 50	795.8	7/ 8/86	55	10.0	4.00	P	G	2.40
WM:N-053A	35 56 54	86 45 50	798.4	9/24/86	203	41.0	6.00	S	G	1.30
				--	--	--	--	--	J	--
				--	--	--	--	--	C	--
				--	--	--	--	--	N	--

Table 1.--Summary of observation well construction near disposal site--Continued

Local well No.	Latitude 0' "	Longitude 0' "	Altitude of land surface above NGVD of 1929, in feet	Date of construction	Depth of well below land surface, in feet	Bottom of casing below land surface, in feet	Diameter of casing interval, in inches	Type of log material available	Height of measuring point above land surface, in feet
WM:N-054	35 57 10	86 45 41	759.8	7/10/86	30	4.50	4.00	G	1.92
WM:N-054A	35 57 10	86 45 41	760.3	10/13/86	139	32.0	6.00	S	2.51
				--	--	--	--	J	
				--	--	--	--	C	
				--	--	--	--	N	
WM:N-055	35 57 14	86 45 45	757.8	7/11/86	30	5.80	4.00	G	2.51
WM:N-055A	35 57 14	86 45 45	758.6	10/13/86	177	26.0	6.00	S	1.70
				--	--	--	--	J	
				--	--	--	--	C	
				--	--	--	--	N	
WM:N-056	35 57 29	86 46 18	803.4	1/ /87	45	13	6.00	P	1.7
WM:N-056A	35 57 29	86 46 18	802.9	1/12/87	67	6.0	6.00	P	1.37
				--	--	--	--	J	
				--	--	--	--	C	
				--	--	--	--	N	
				--	--	--	--	J	
WM:N-057	35 57 13	86 45 52	793.5	1/ 9/87	57	10	6.00	P	Pressure gage
WM:N-057A	35 57 13	86 45 52	794.8	1/ 8/87	204	57	6.00	P	0.75
				--	--	--	--	J	
				--	--	--	--	C	
WM:N-058	35 57 11	86 46 31	756.5	1/ 8/87	35	13	6.00	G	1.33
WM:N-058A	35 57 11	86 46 31	757.0	2/ 9/87	165	35	6.00	P	1.49
				--	--	--	--	J	
				--	--	--	--	C	

Well construction was completed in two stages. During the first stage of drilling, 14 shallow wells were installed using the water-air rotary method. A 6-inch diameter hole was drilled and 4-inch diameter steel or PVC surface casing was installed at least 1 foot into bedrock. Casing lengths in these shallow wells ranged from 4 to 20 feet. Bentonite pellets were poured down the annulus of the well to the base of the casing to form a seal at least 1 foot thick. A Portland type 1 cement slurry was poured into the annulus around the casing with a tremie pipe to form a seal from the top of the bentonite to ground surface. Drilling continued through the casing into the shallow bedrock aquifer. The open-hole diameter of the shallow wells was 4 inches and total depths ranged from 20 to 49 feet below land surface.

During the second stage of drilling, the remaining wells were air-rotary drilled to a final diameter of 6 inches. For three shallow wells drilled during this stage, 6-inch PVC casing was set at least 1 foot into bedrock. The depths of these wells ranged from 35 to 57 feet. For the 17 deep wells, 6-inch steel or PVC casing was installed in a 9- or 10-inch diameter hole through the upper aquifer. Casing was set 5 to 10 feet into the Hermitage Formation in order to avoid water exchange between the upper and lower aquifers. A seal of bentonite pellets was poured at the base of the casing to a thickness of at least 1 foot. The annular space was grouted from the top of the bentonite seal to land surface. Drilling continued below the casing depth after allowing the grout to set for at least 24 hours.

Lithologic Descriptions

Rock cuttings were collected during well construction and were used to determine the lithology of the formations. The samples were collected at 5-foot intervals, and a geologic log was kept for each well. Four general limestone

lithologies were identified: the Bigby-Cannon Limestone, the Hermitage Formation, the Carters Limestone (with T-3 bentonite), and the Lebanon Limestone.

Description of the lithologies was based on previous work by Wilson and Miller (1963). Generally, the Bigby-Cannon Limestone consists of three facies: The Cannon facies, which consists of medium dark-gray to brownish-black microcrystalline to medium-grained limestone; the Dove-colored limestone facies which is medium light-gray cryptocrystalline limestone; and the Bigby facies, which is a medium light-gray to brownish-gray coarse-grained calcarenite. The Hermitage Formation consists of two facies, the coquina facies at the top of the section, which is medium-gray to brownish-gray limestone disseminated with silt and shale partings and brachiopod shell fragments (*Resserella fertilis*). The laminated argillaceous limestone facies is silty to sandy, medium- to dark-gray in color, and very fine to medium grained. The Carters Limestone consists of the upper member, which is brownish-gray and yellowish-brown, very fine-grained to cryptocrystalline limestone; the T-3 bentonite, known as "Pencil Cave" in driller's terminology; and the lower member, which is brownish-gray to yellowish-brown cryptocrystalline limestone with some medium- to coarse-grained beds. The Lebanon Limestone is medium dark-gray to yellowish-brown cryptocrystalline limestone. Lithologic data for each site are summarized in Appendix A.

Geophysical Logs

Geophysical logs were obtained for all the deep wells. Caliper and gamma logs were obtained at each site. Gamma-gamma density and (or) neutron logs were obtained from wells Wm:N-041A, Wm:N-042A, Wm:N-045A, Wm:N-046A, Wm:N-047A, Wm:N-048A,

Wm:N-050A, Wm:N-51A, Wm:N-53A, Wm:N-054A, Wm:N-055A, and Wm:N-058A. The suite of logs for each well is presented in Appendix A.

The gamma log for each well was used in conjunction with the geologic log obtained in the field to determine geologic contacts. For example, the gradual increase in counts per second of the gamma logs suggests that the Hermitage Formation has a high clay content. The Carters Limestone is almost pure limestone and, as such, shows a very low number of counts per second. As depth increases, this overall low count is followed by a sudden increase in the number of counts per second, denoting the T-3 bentonite, which is a particularly distinct marker bed.

Water-Level Data

Water-level measurements were made periodically after completion of the drilling. Measurements are from a standard measuring

point using a steel tape. A summary of the water-level data is presented in table 2.

Variability of water levels in the shallow system range from 36 feet below land surface to 14 feet above land surface. Variability of water levels in the deep system range from 144.52 feet to about 9 feet below land surface. Fluctuations of water levels within individual shallow and deep wells can be seen in table 2. All but one well are fully recovered. Well Wm:N-056A, completed in January 1987, was not fully recovered as of April 1987.

REFERENCES

- Wilson, C.W., Jr., and Miller, R.A., 1963, Geologic map and mineral resources summary for the Franklin quadrangle, Tennessee: Tennessee Department of Conservation, Division of Geology, scale 1:24,000, 1 sheet.

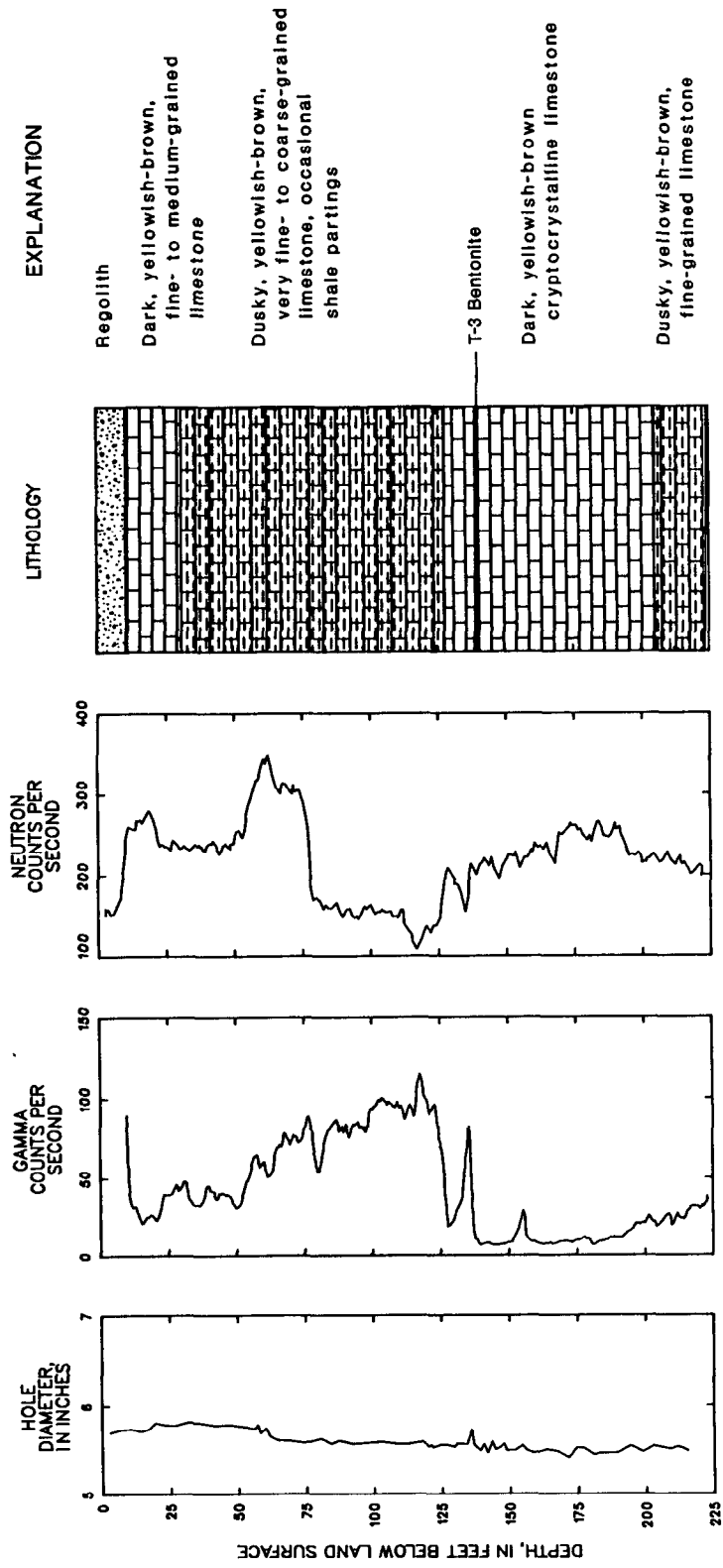
Table 2.--Depth to water, in feet below land surface, in observation wells near disposal site
[+, indicates water level above land surface]

Well No.	Dates of measurements																
	7/25/86	7/29/86	8/11/86	8/18/86	8/25/86	9/5/86	9/19/86	10/20/86	10/28/86	11/10/86	11/18/86	11/28/86	2/5/87	3/6/87	3/17/87	4/6/87	4/20/87
WM:N-041	28.97	29.48	29.14	28.27	28.18	27.37	27.75	27.54	27.24	10.50	10.02	9.78	10.05	9.99	21.70	22.44	22.28
WM:N-041A	--	--	--	--	--	--	--	78.01	96.73	61.70	53.71	49.02	39.13	36.69	36.97	38.02	38.35
WM:N-042	18.42	--	17.92	17.17	17.79	16.22	17.28	17.17	17.00	9.04	15.76	8.63	15.06	12.57	15.48	16.76	15.52
WM:N-042A	--	--	--	--	--	--	--	17.48	16.99	12.80	16.17	12.62	15.76	14.42	16.68	16.78	16.60
WM:N-043	24.43	24.44	24.44	24.24	24.40	24.39	19.03	19.03	19.02	18.46	17.90	16.72	25.53	22.67	22.51	22.38	22.86
WM:N-043A	--	--	--	--	--	--	--	10.78	10.27	8.89	9.08	8.54	9.27	8.80	9.70	10.43	9.59
WM:N-044	17.27	16.19	15.19	10.12	10.46	9.95	10.39	10.27	10.12	7.85	10.06	8.82	10.06	10.03	10.20	10.45	10.05
WM:N-044A	--	--	--	--	--	--	--	--	10.47	9.18	9.52	8.90	9.57	9.17	10.02	10.74	10.47
WM:N-045	33.83	--	33.19	33.93	33.93	33.88	33.93	33.10	32.54	18.54	30.16	16.76	30.94	24.69	31.00	31.49	29.50
WM:N-045A	--	--	--	--	--	--	--	107.16	106.15	94.96	86.83	82.25	71.46	69.14	68.95	69.90	70.26
WM:N-046	24.11	--	22.84	22.17	21.76	20.33	19.43	17.85	16.92	4.47	4.77	4.73	4.98	4.91	5.51	9.21	10.45
WM:N-046A	--	--	--	--	--	--	--	56.26	37.29	31.83	30.50	30.14	29.57	27.04	26.21	25.14	21.61
WM:N-047	12.20	--	13.03	13.14	13.17	13.33	9.07	11.70	11.00	4.12	5.54	4.45	5.92	5.41	6.98	7.91	8.43
WM:N-047A	--	--	--	--	--	--	--	79.64	48.17	48.96	47.28	45.48	35.83	33.65	32.97	31.81	31.25
WM:N-048	21.57	--	21.51	21.51	21.48	21.45	21.47	28.00	21.35	11.10	--	21.71	--	--	27.55	21.38	21.53
WM:N-048A	--	--	--	--	--	--	--	100.19	99.08	95.14	89.15	84.23	71.81	69.86	68.78	68.90	69.01
WM:N-050	12.02	--	12.06	12.02	12.02	11.74	12.02	12.06	12.01	11.60	11.65	11.61	11.70	15.67	11.91	12.03	11.97
WM:N-050A	--	--	--	--	--	--	--	144.52	134.89	124.29	115.76	108.94	80.82	74.97	73.22	70.58	69.02
WM:N-051	13.27	--	13.31	13.04	13.28	12.30	13.02	13.00	12.88	9.86	10.76	10.40	11.63	10.54	11.71	12.40	12.26
WM:N-051A	--	--	--	--	--	--	--	76.86	58.43	47.66	44.29	41.93	36.46	35.48	35.09	34.58	34.29
WM:N-052	19.62	--	19.66	19.68	19.67	19.70	19.58	19.69	19.83	19.78	19.77	19.56	19.50	19.30	19.51	19.53	19.54
WM:N-052A	--	--	--	--	--	--	--	96.13	83.73	71.44	66.65	62.70	57.94	61.91	63.16	64.76	65.47
WM:N-053	35.72	--	35.69	--	35.71	35.77	35.68	35.62	35.50	19.44	35.09	27.54	35.09	28.38	35.29	35.35	35.32
WM:N-053A	--	--	--	--	--	--	--	137.25	120.55	101.39	92.56	84.07	63.79	62.30	61.76	61.49	62.43
WM:N-054	3.59	3.55	3.47	2.80	3.14	1.57	2.68	2.54	2.17	.83	3.12	1.92	2.69	2.53	2.87	2.85	2.66
WM:N-054A	--	--	--	--	--	--	--	57.00	55.70	40.59	32.07	27.38	17.85	15.36	15.66	16.73	17.04
WM:N-055	14.20	14.48	14.86	14.58	14.46	13.80	13.77	14.93	14.84	13.24	13.35	12.78	14.32	13.47	15.09	14.40	14.08
WM:N-055A	--	--	--	--	--	--	--	54.49	53.35	39.96	32.44	27.73	18.03	15.78	14.94	16.78	17.00
WM:N-056	--	--	--	--	--	--	--	--	--	--	--	--	22.24	17.04	22.06	23.31	23.19
WM:N-056A	--	--	--	--	--	--	--	--	--	--	--	--	113.22	100.78	98.83	97.11	96.26
WM:N-057	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+14.00
WM:N-057A	--	--	--	--	--	--	--	--	--	--	--	--	51.69	48.75	49.52	50.71	57.27
WM:N-058	--	--	--	--	--	--	--	--	--	--	--	--	16.84	20.88	16.99	17.08	17.01
WM:N-058A	--	--	--	--	--	--	--	--	--	--	--	--	16.42	16.43	17.09	16.59	16.34

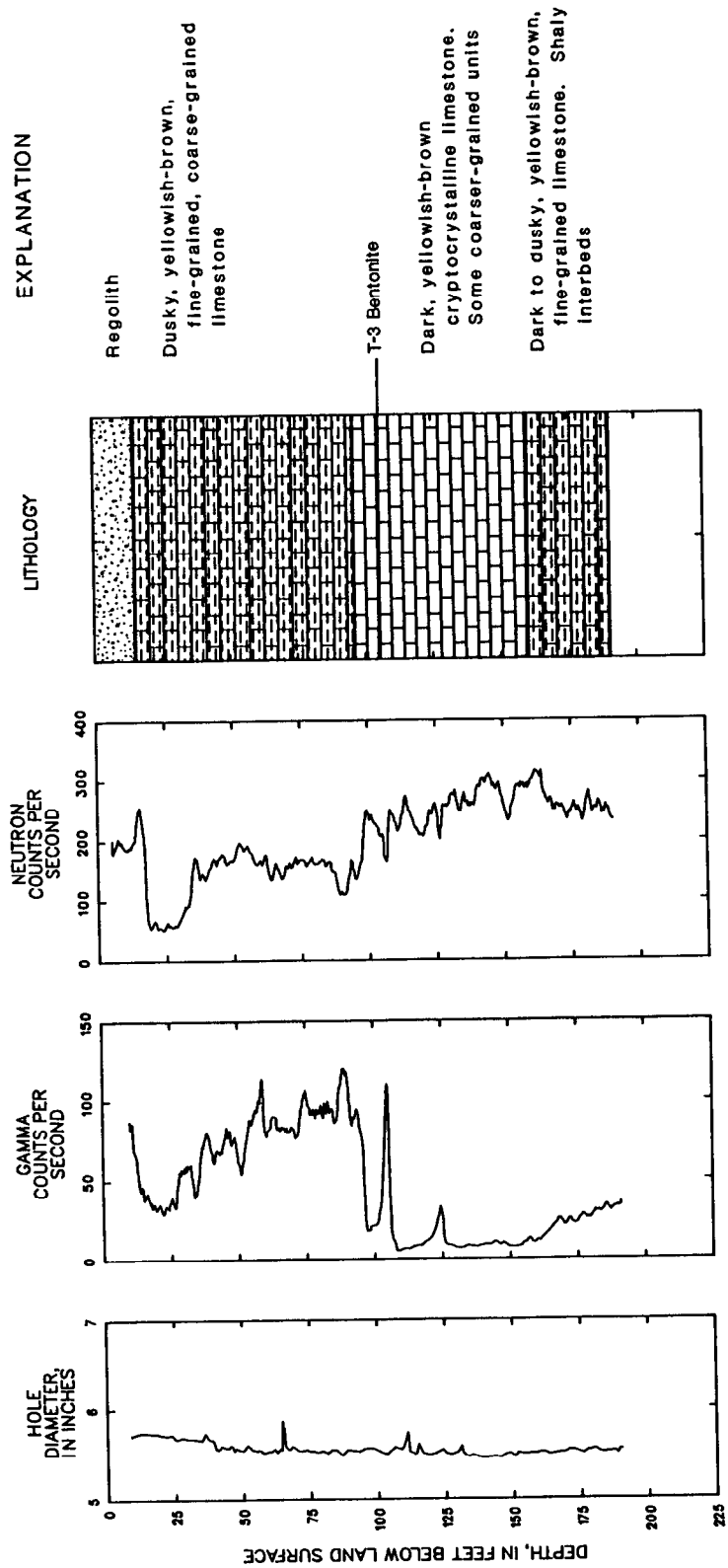
Appendix A

Geophysical and lithologic logs for deep observation wells

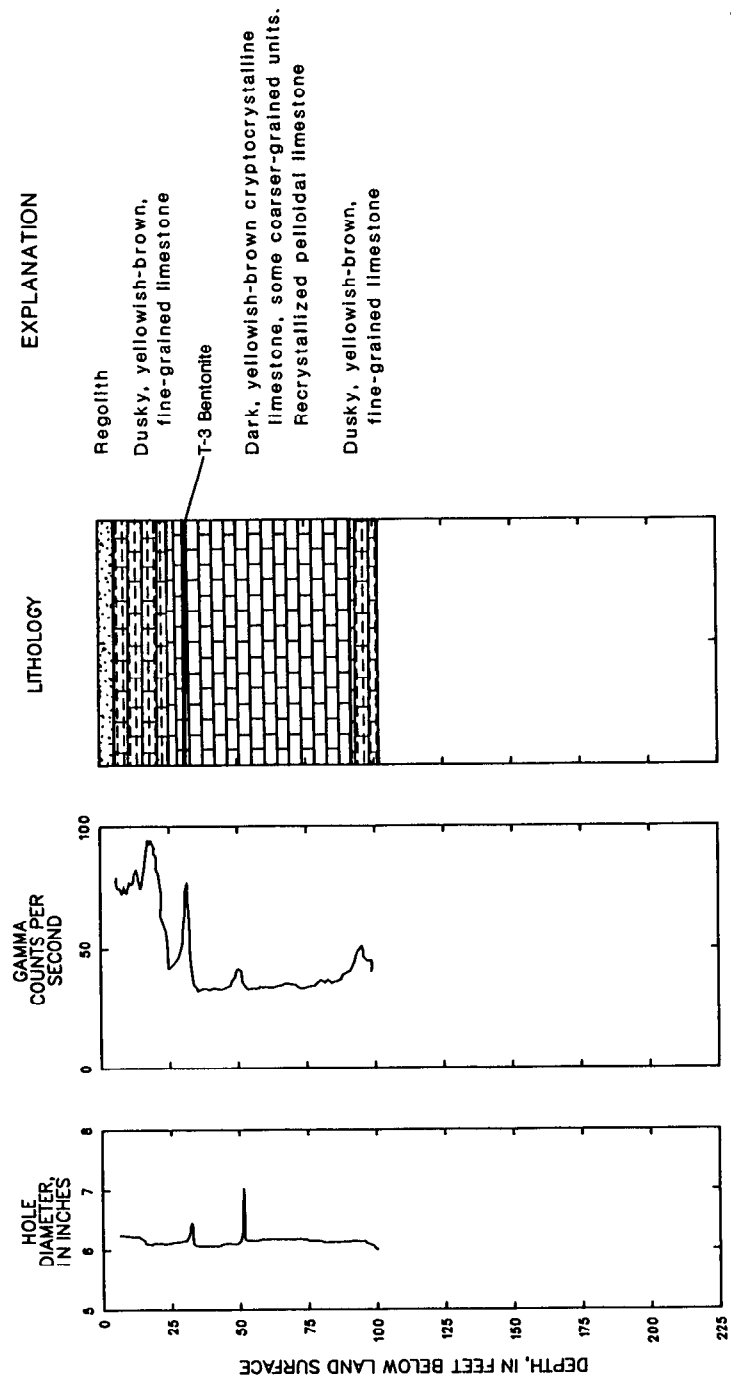
WELL WM:N-O41A



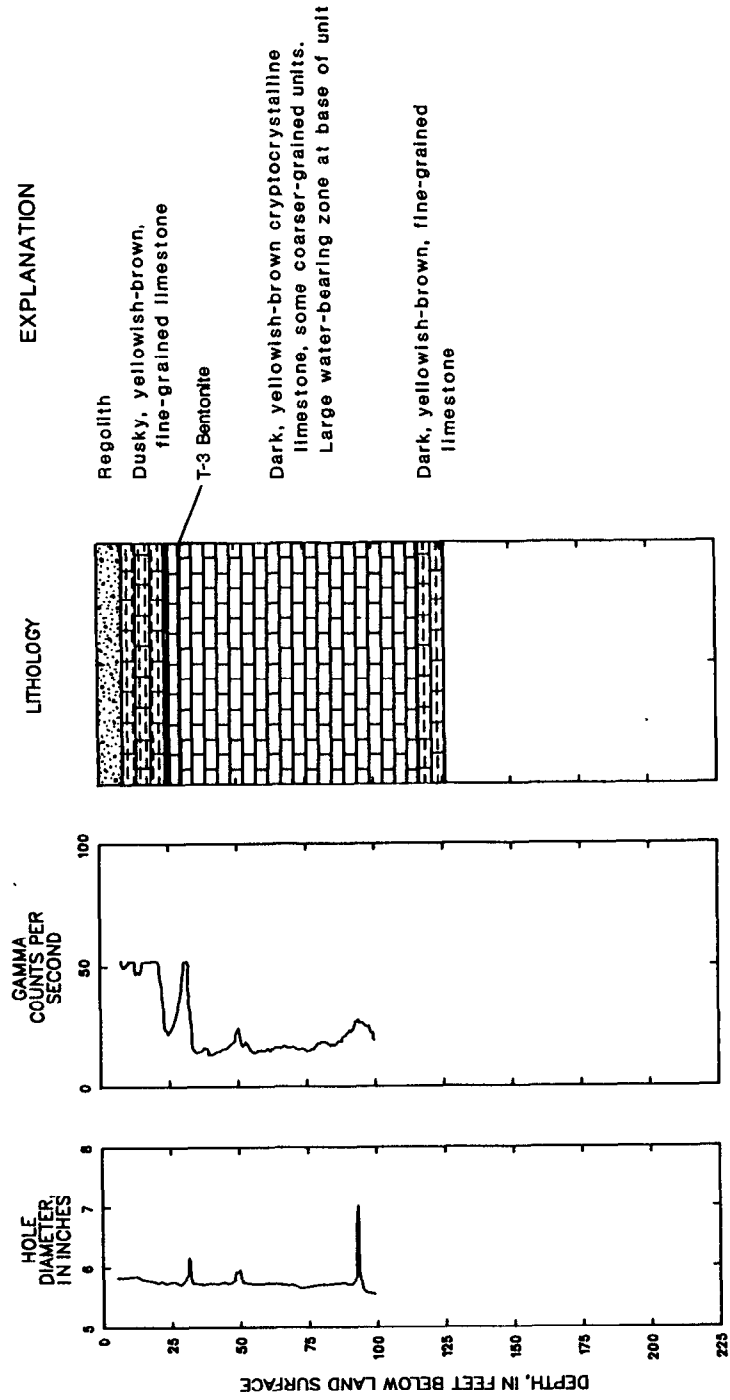
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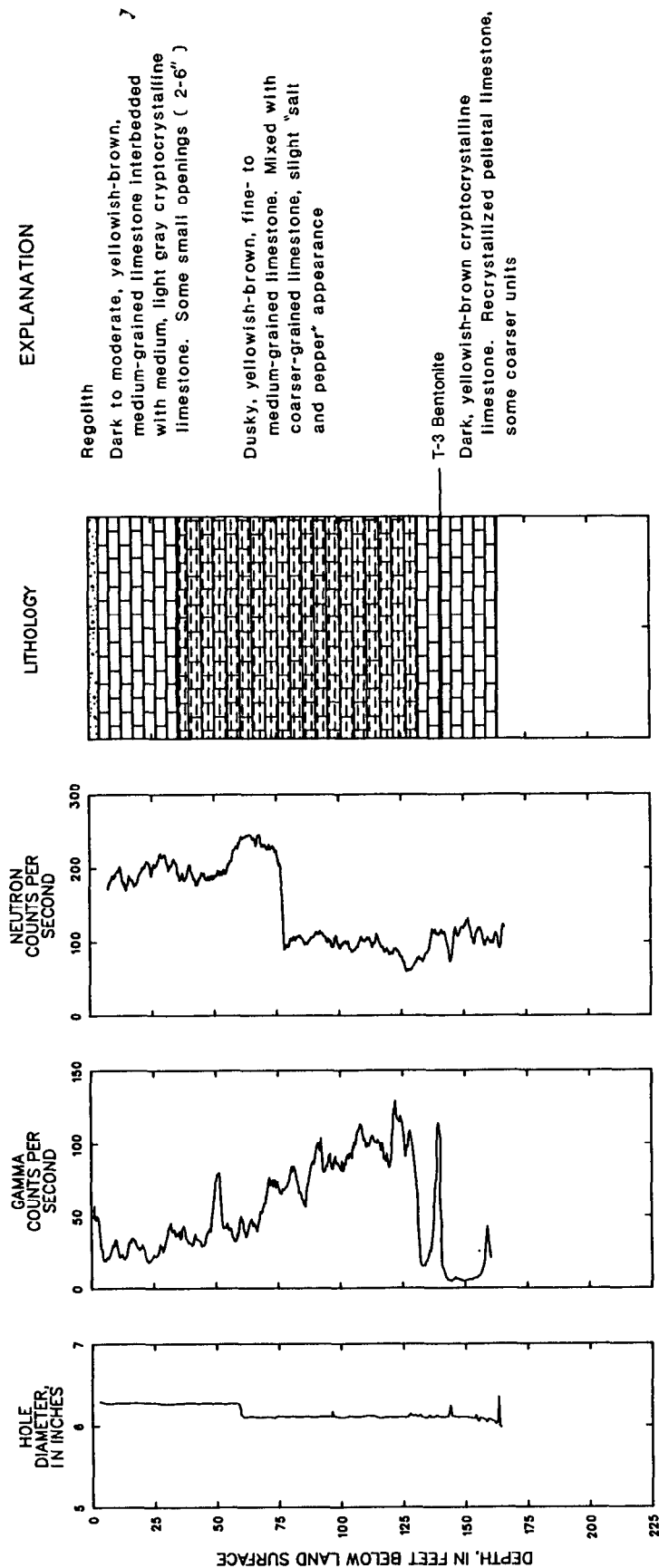
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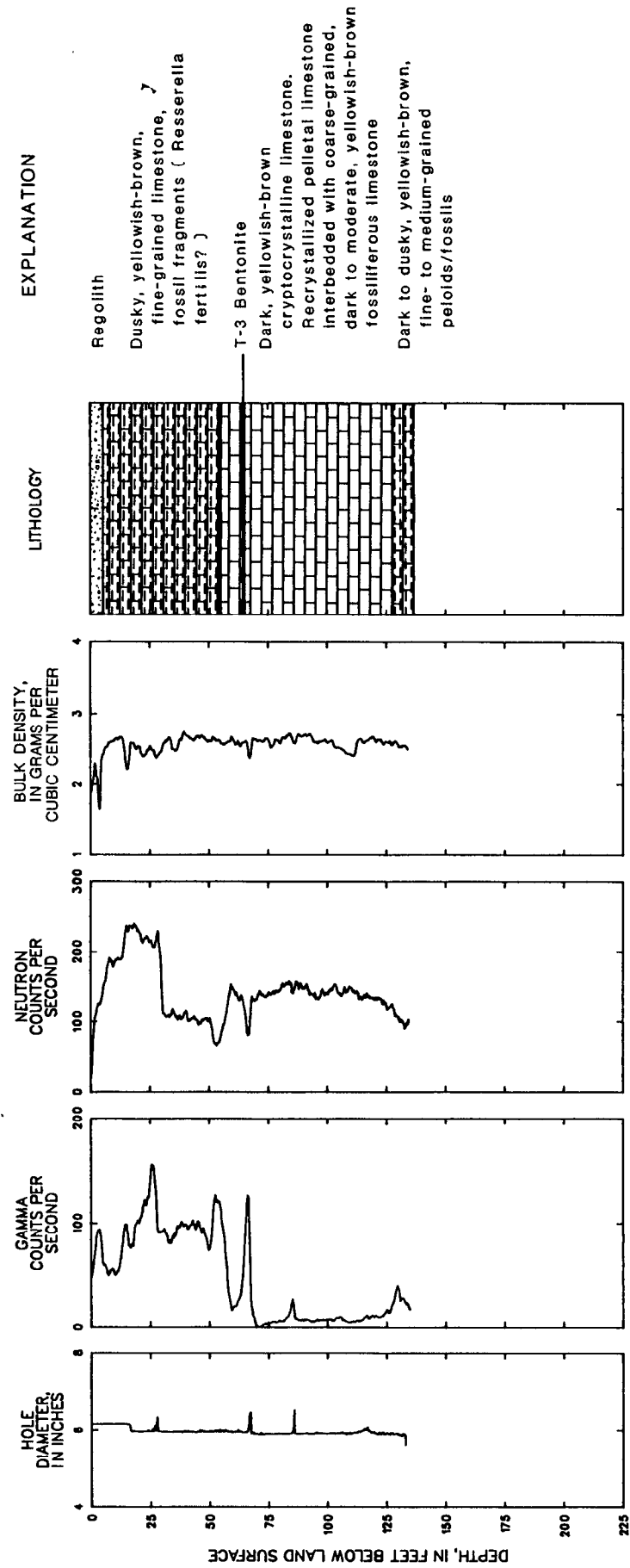
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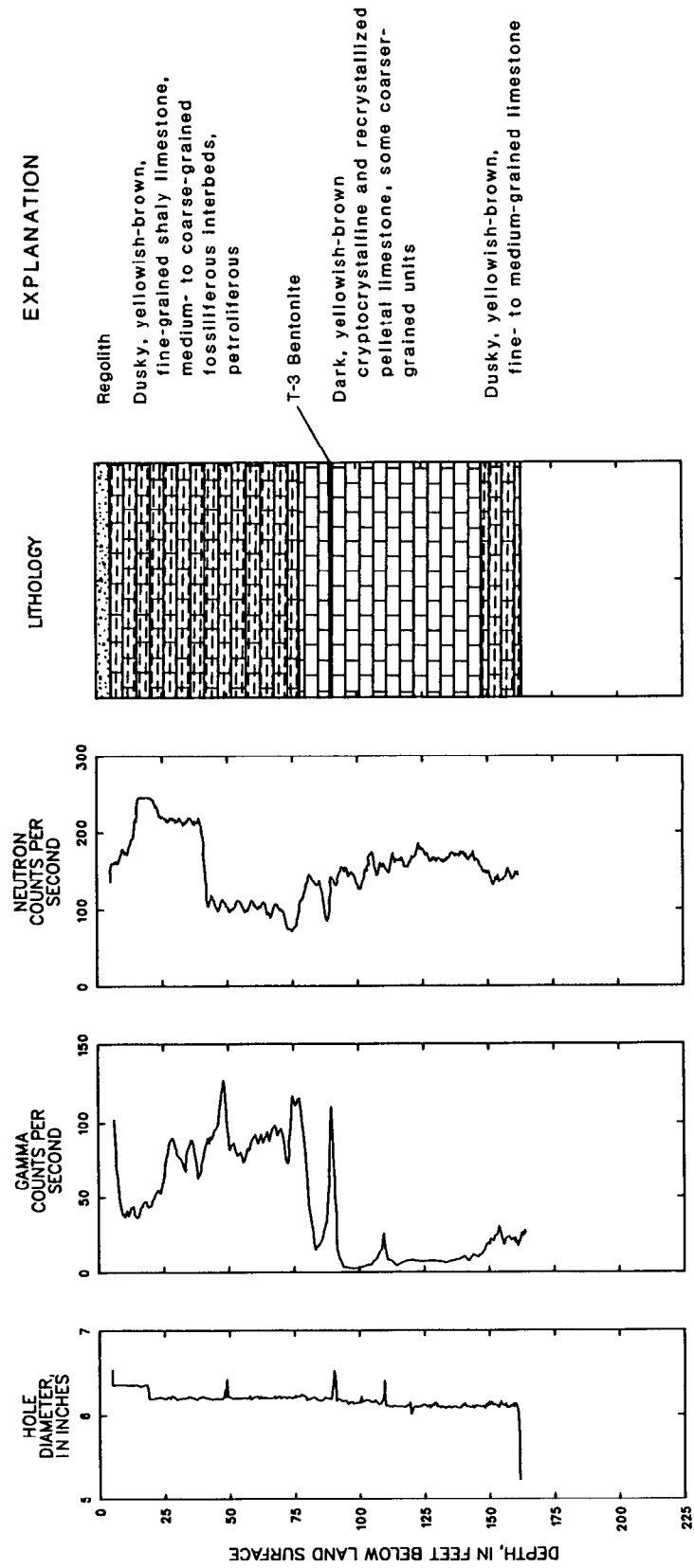
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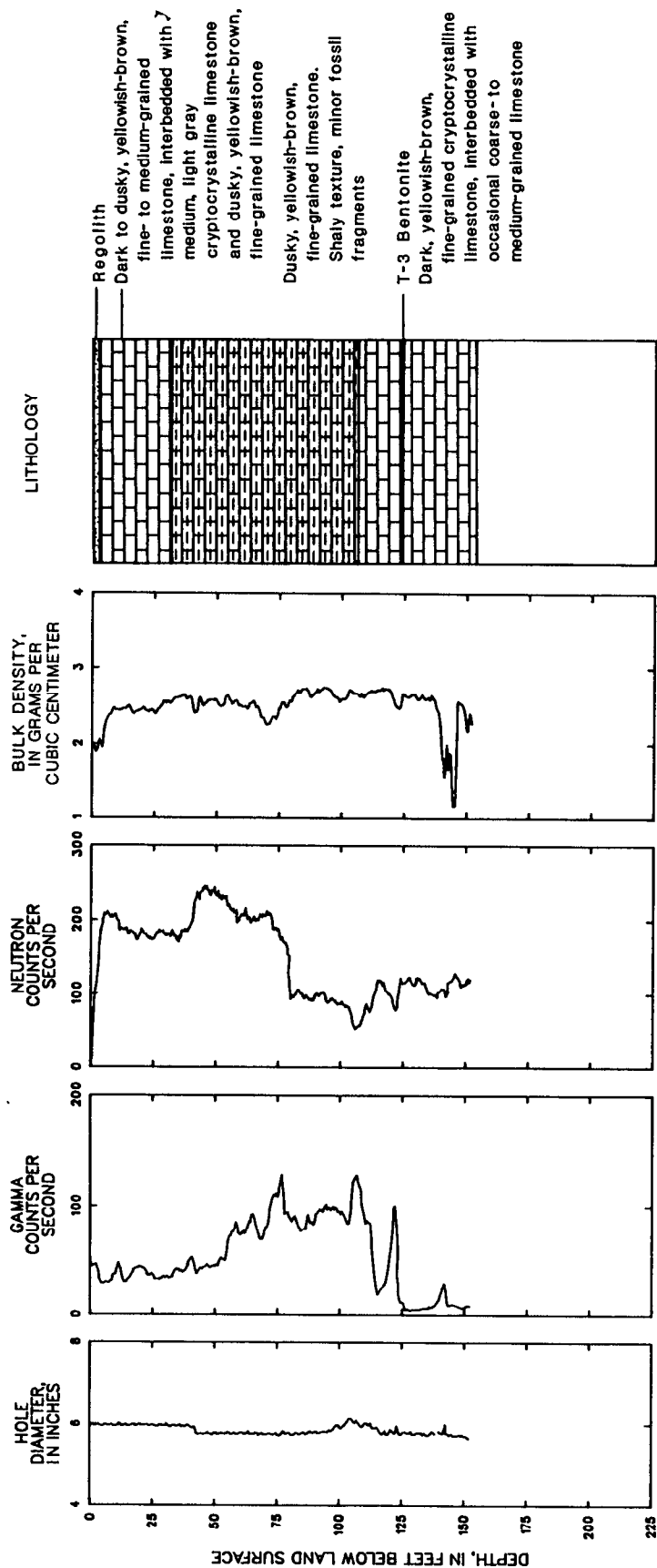
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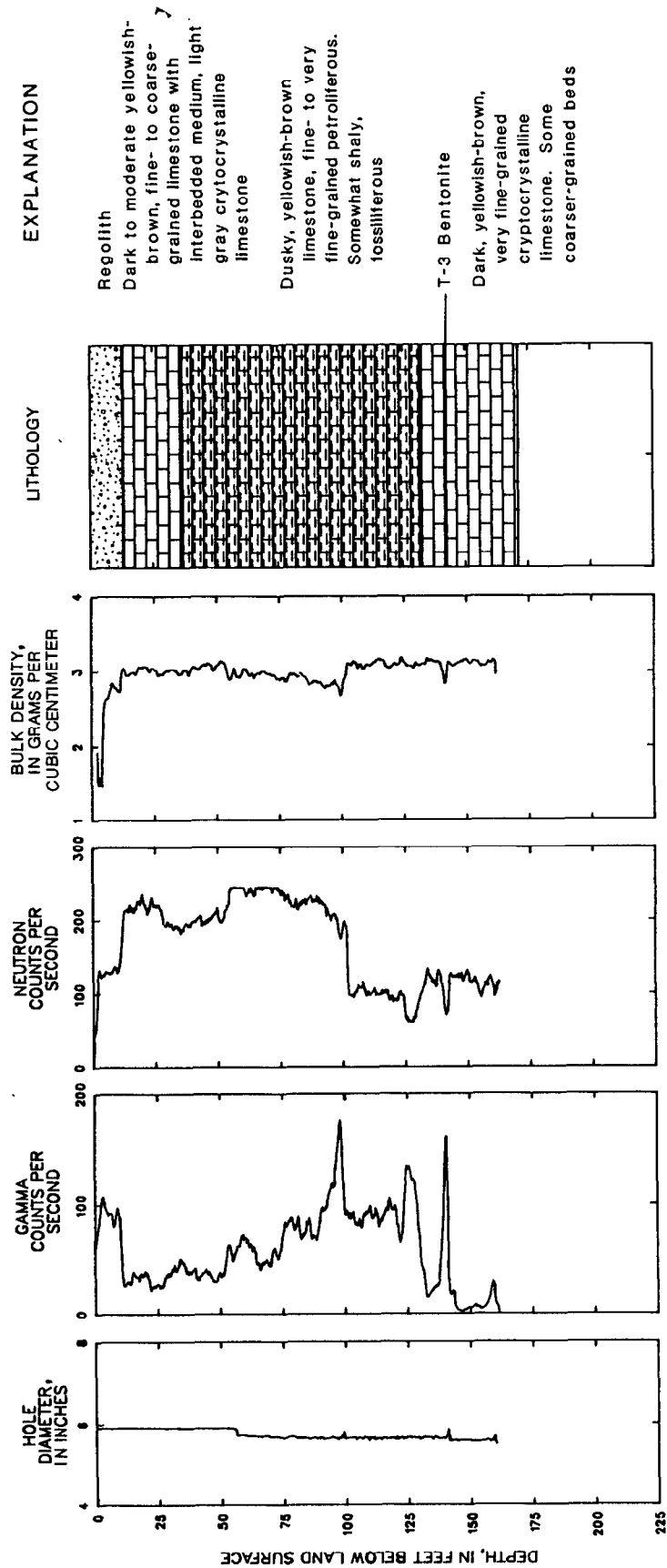
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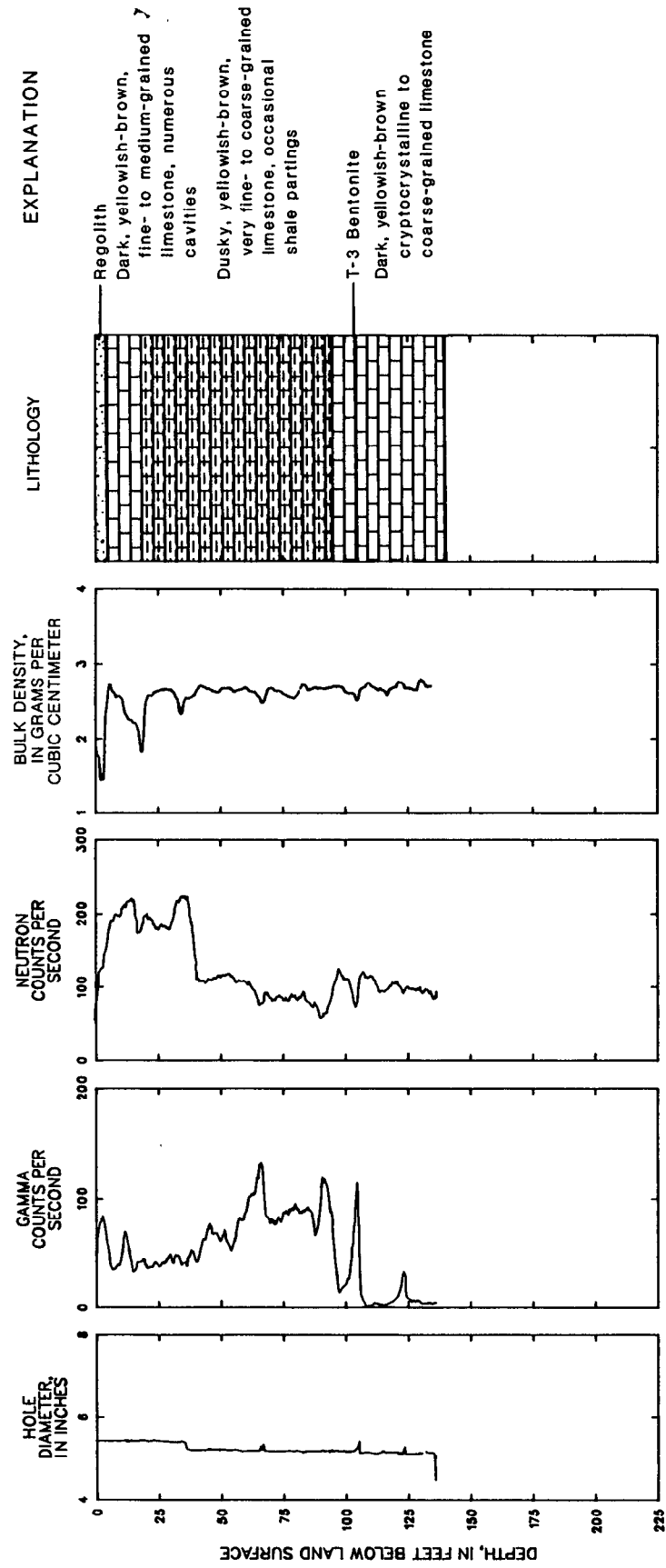
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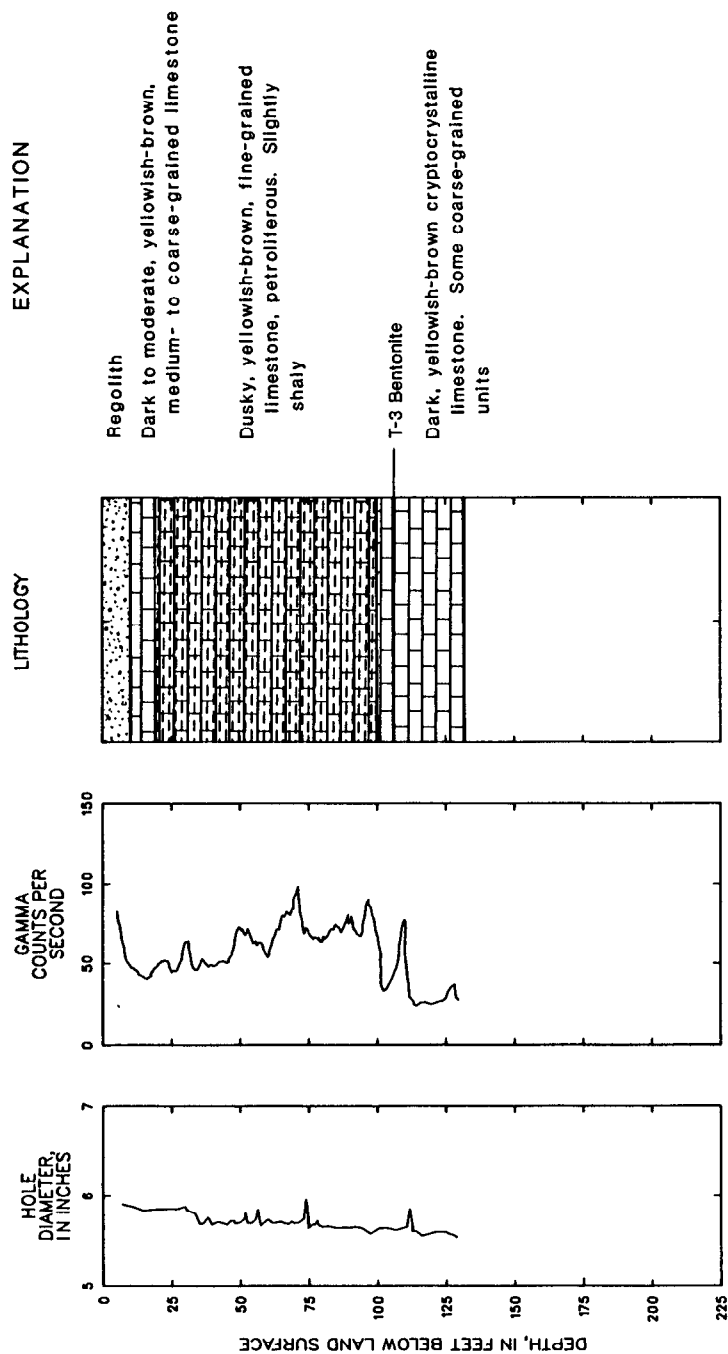
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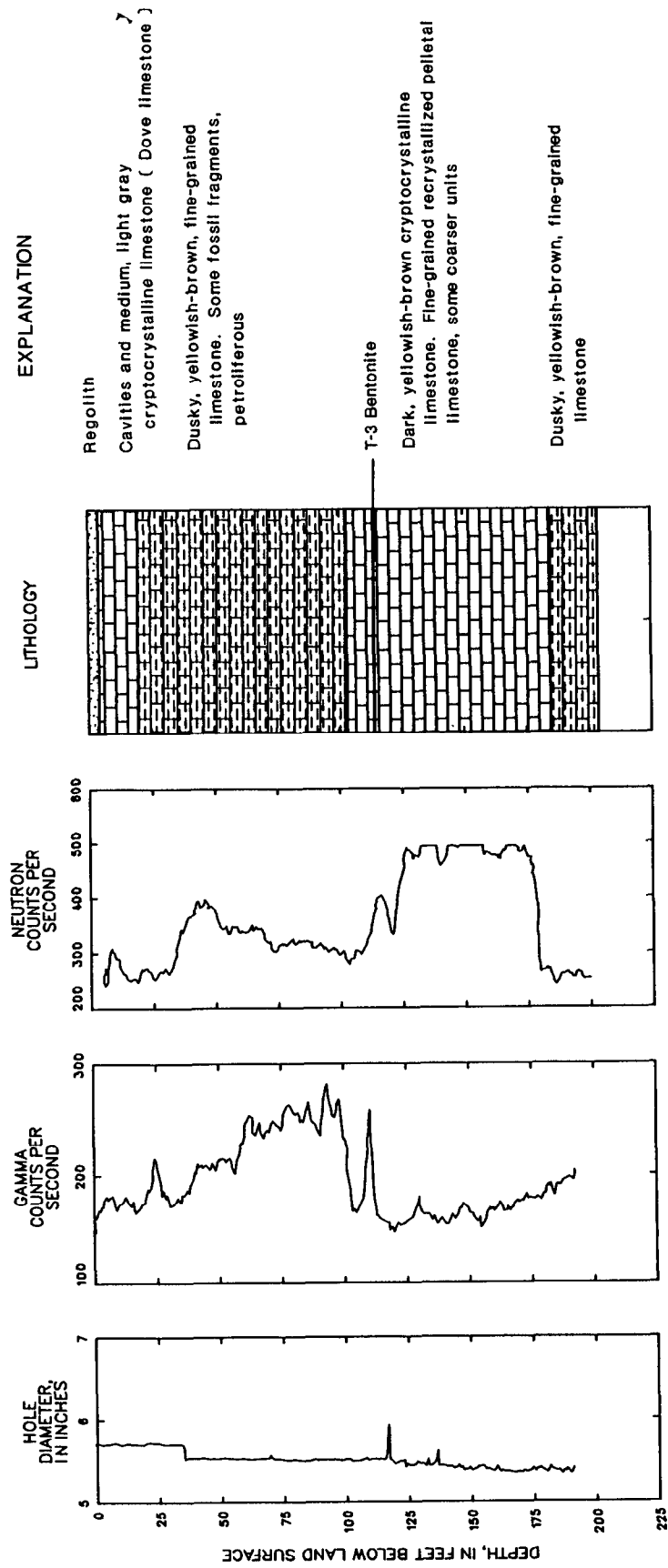
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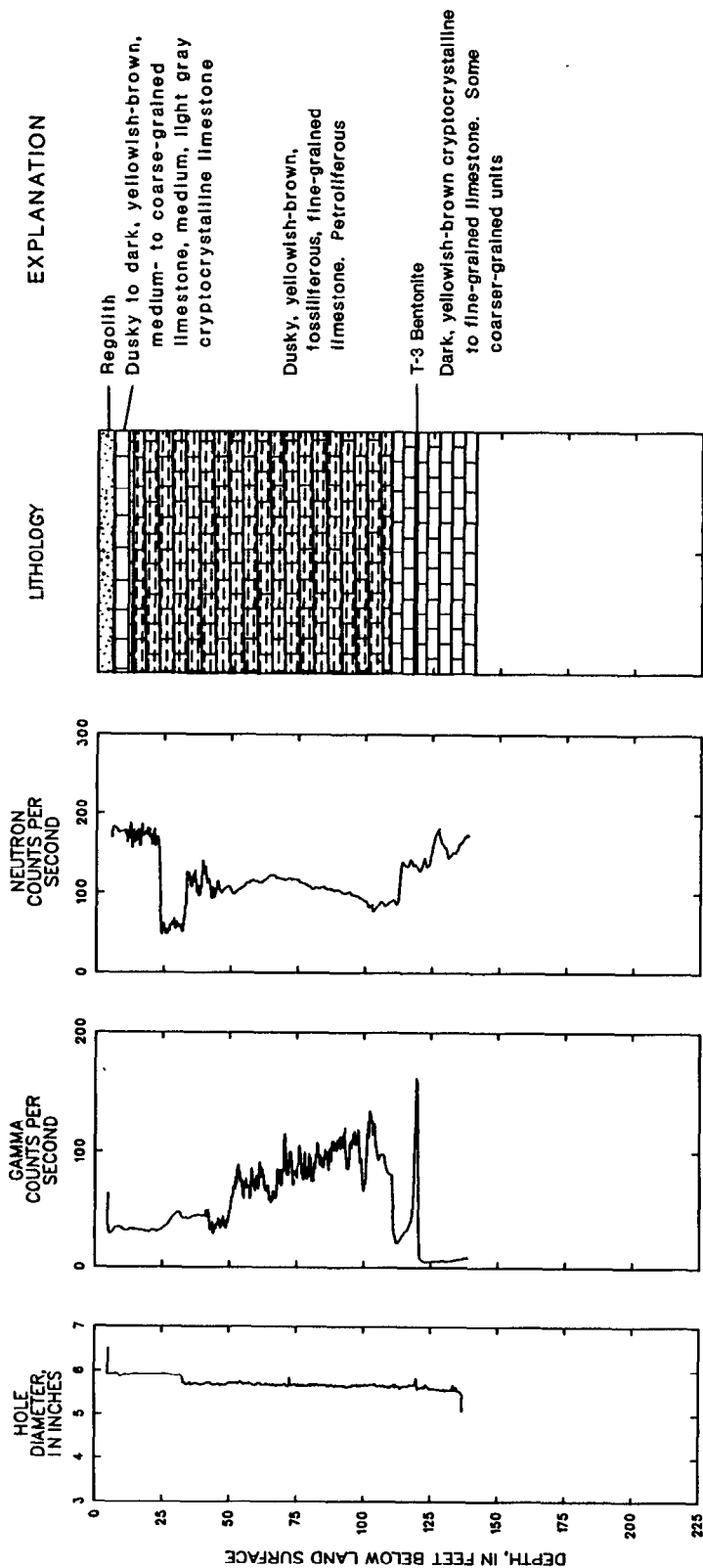
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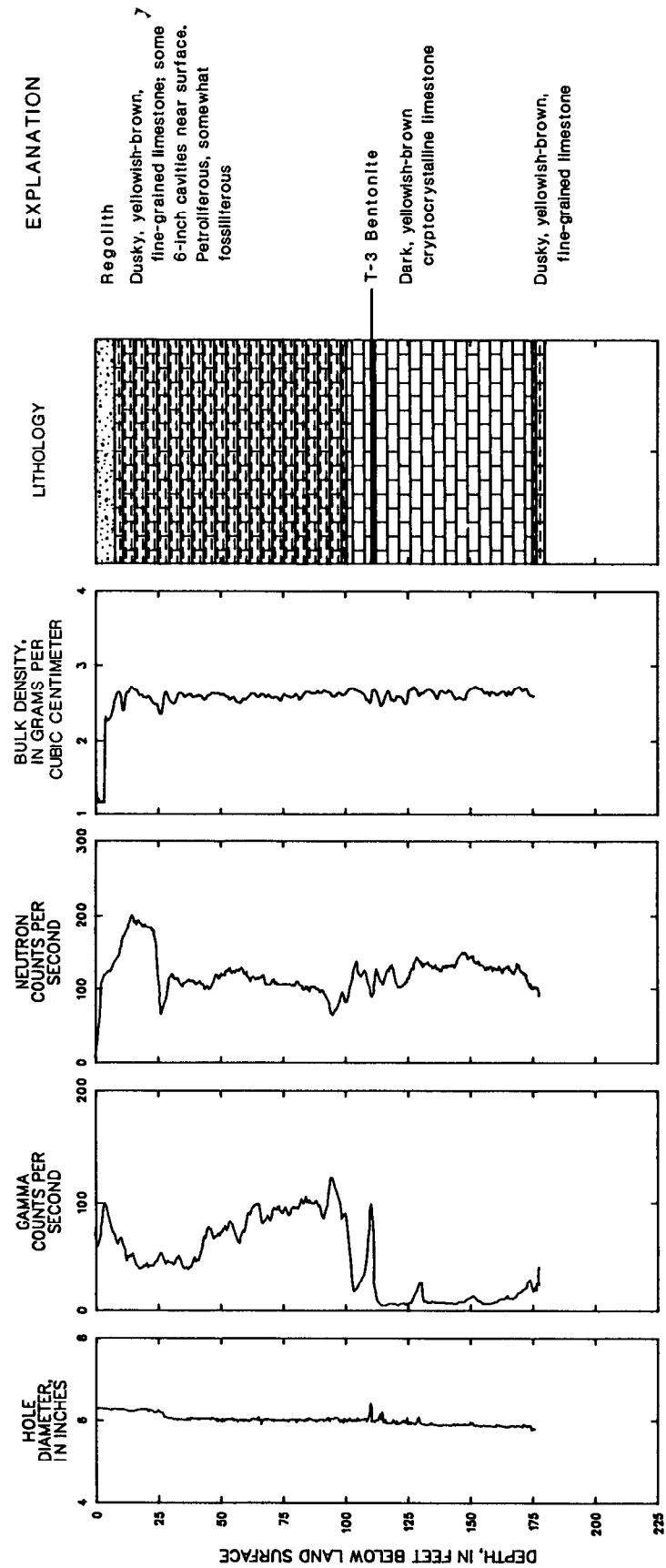
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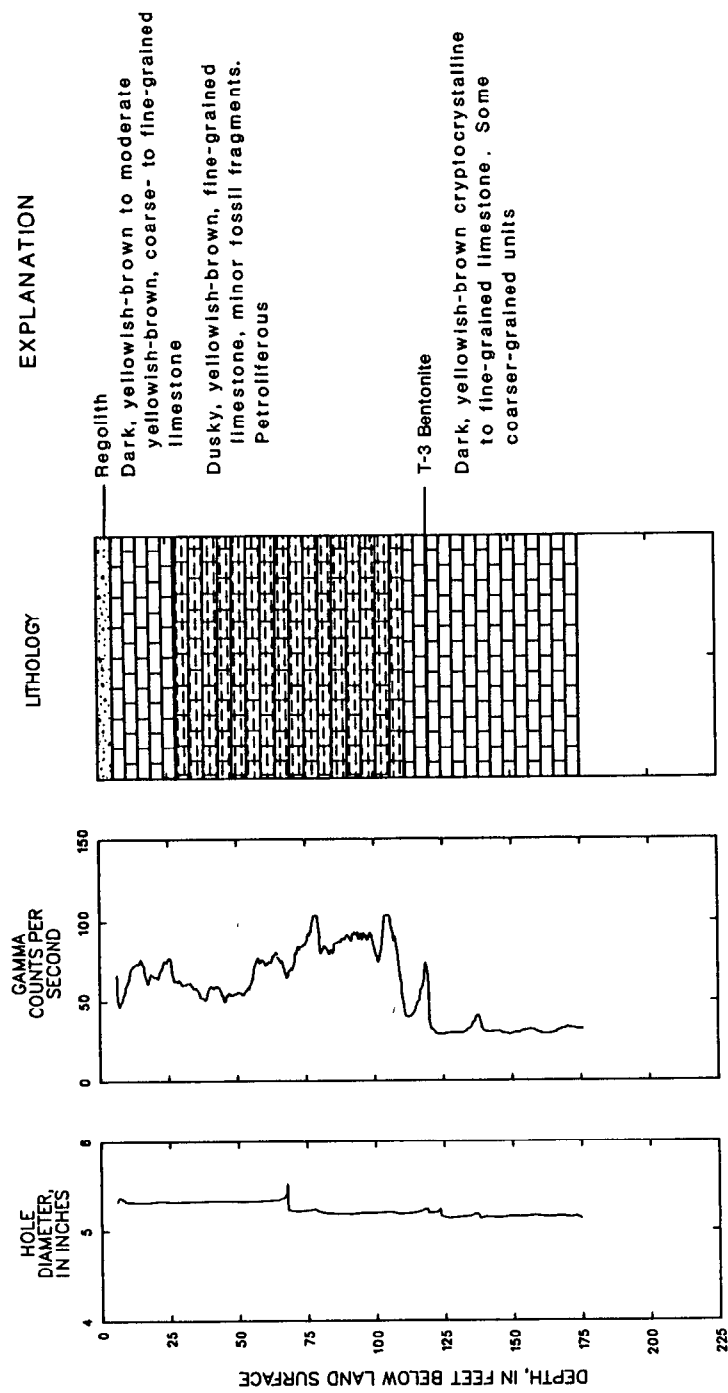
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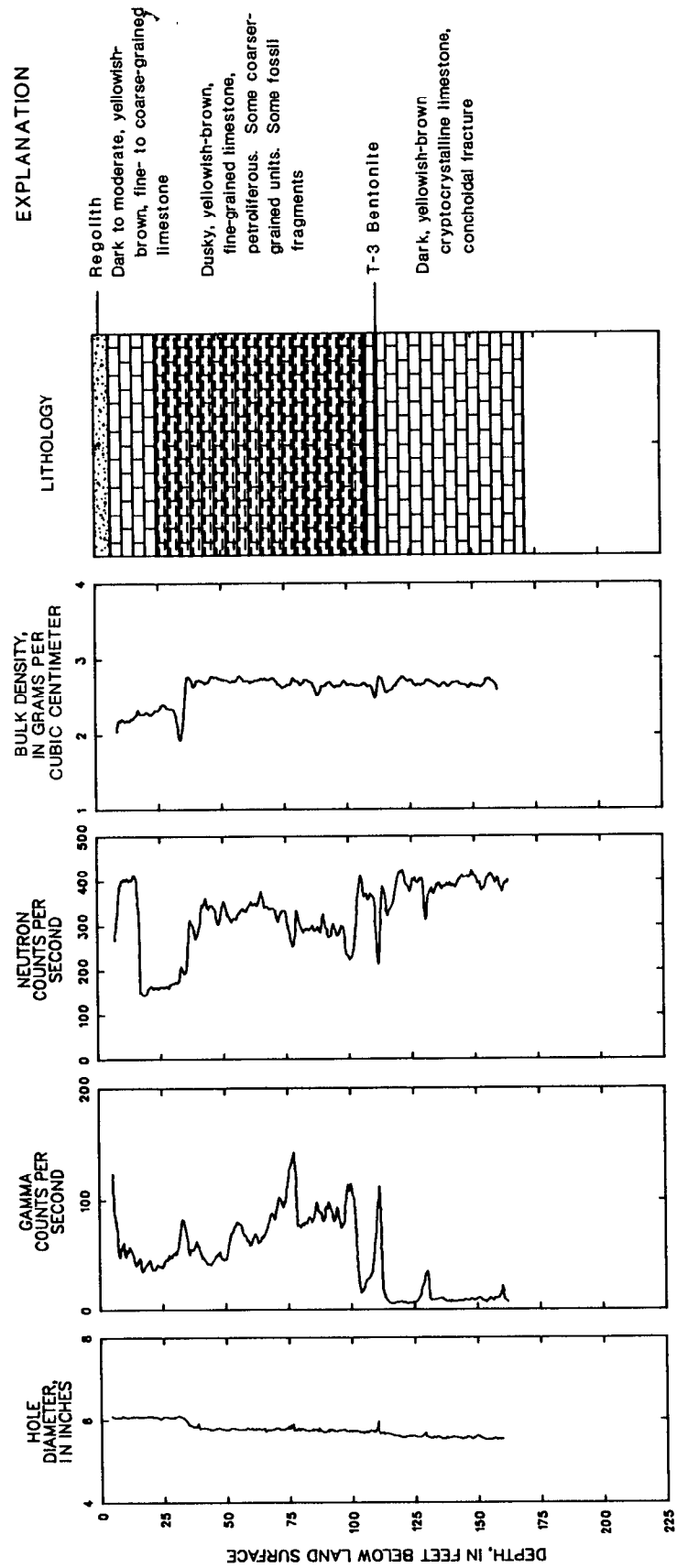
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WELL WM:N-056A



WELL WM:N-058A



WELL WM:N-057A

